

III. REMARKS

Claims 1, 4-5, 7-8, 11, 13, 15-17, and 19-20 are pending in this application. By this Amendment, claims 1, 11, and 17 have been amended; and claims 6, 14, and 18 have been canceled. Claims 2-3, 9-10, and 12 have been canceled previously. Applicants are not conceding in this application that those claims are not patentable over art cited by the Examiner, as the present claim amendments and cancellations are for facilitating expeditious allowance of the claimed subject matter. Further, Applicants reserve the right to pursue the full scope of the subject matter of the original claims in a subsequent patent application that claims priority to the instant application. Reconsideration in view of the following remarks is respectfully requested.

In the final Office Action, claims 1, 4-11, and 13-20 are rejected under 35 U.S.C. § 103(a). Claims 1 and 7 are rejected as allegedly being unpatentable over Nitta et. al. (US Pub. No. 2001/0054764, hereinafter “Nitta”) in view of Dubin (Pat. No. 6,359,328, hereinafter “Dubin”) and Roberts (US Pat. No. 6,204,143, hereinafter, “Roberts”); claims 4-5, 11, 13, 15, 17, and 19 are rejected as allegedly being unpatentable over Nitta in view of Dubin, Roberts, and Cooney, et. al. (US Pub. No. 2004/0018714, hereinafter “Cooney”); claim 8 is rejected as allegedly being unpatentable over Nitta in view of Dubin and Roberts, and further in view of Parekh (US Pat. No. 6,214,727, hereinafter, “Parekh”); claims 16 and 20 are rejected as allegedly being unpatentable over Nitta in view of Dubin, Roberts, and Cooney, and in further view of Parekh; and claims 6, 11, 14, 17 and 18 are rejected as being allegedly unpatentable over Nitta in view of Dubin, Roberts, and Tsai (US Pub. No. 2003/0077897, hereinafter “Tsai”).

With regard to independent claims 1, 11, and 17, Applicants respectfully traverse

the respective rejections noted above, as Applicants submit that Nitta, Dubin, and Roberts do not teach or suggest each and every feature of claim 1; and Nitta, Dubin, Roberts, and Cooney similarly fail to teach or suggest each and every element of claims 11 and 17.

For example, Applicants submit that the cited references fail to teach the feature of “removing the sacrificial layer sidewall ..., *forming a void, wherein the void extends along a side of the contact via and the wire.*” (Claim 1, lines 17-19; claim 11, lines 18-20; and similarly recited in claim 17, lines 18-20.) As noted in the Office Action, Nitta fails to teach “wherein the void extends along a side of the contact via.” (Final Office Action, p. 3.) Instead, Nitta teaches a spacer 41 formed along wiring pattern groove 13. (Nitta, [0067].) As is apparent in Nitta's FIGS. 5A-G and 6A-E, spacer 41 does not “extend[] along a side of the contact via.”

In the Final Office Action, the Office relies on Dubin at FIGS. 1-5, item 24a-b to teach the claimed method of forming a gas dielectric structure for a semiconductor structure “wherein the void extends along a side of the contact via.” The Office does not assert, however, that Dubin, or any other reference, teaches “wherein the void extends along a side of the contact via *and the wire*,” as recited in claim 1. At FIG. 3 and accompanying text, Dubin teaches “remov[ing] the anti-bonding material from the contact plugs to form gaps 24a and 24b between plugs 22a and 22b and the interior sidewalls of holes 18a and 18b” (Dubin, col. 5, ln. 43-46; FIG. 3). As shown in FIG. 4, “gaps 24a and 24b ... define respective cylindrical air cavities or 'air tubes' around plugs 22a and 22b.” (Dubin, col. 5, ln. 49-51; FIG. 4.) As is clearly shown in Dubin's FIGS. 3 and 5, however, gaps 24a-b only extend along plugs 22a-b. Gaps 24a-b do not extend

along conductors, or wires, 14a-b. Roberts is neither relied upon, nor teaches this feature, which is clearly absent in Nitta and Dubin.

In addition to the deficiencies noted above, Applicants have amended claims 1, 11, and 17 without prejudice to recite the features of “depositing a non-conductive liner, wherein the non-conductiafter depositing the non-conductive liner,ve liner includes one of the group consisting of: silicon nitride (Si_3N_4) and silicon dioxide (SiO_2); [and] depositing a sacrificial layer...” (claims 1, 11, and 17 at lines 6-8), which Applicants submit is neither taught nor suggested by the cited art. No new matter is added in the course of this amendment, as the feature was previously recited at claims 6, 14, and 18, and finds support in the specification as filed at p. 7, ln. 22 through p. 8, ln. 4.

In the Office Action, the Office asserts that Tsai teaches the feature of “depositing a non-conductive liner prior to ... depositing the sacrificial layer, wherein the non-conductive liner includes one of the group consisting of: silicon nitride (Si_3N_4) and silicon dioxide (SiO_2),” and further, that a person having ordinary skill in the art would be motivated to combine Nitta, Dubin, and Roberts with Tsai's teachings “for at least the purpose of forming a protective layer to prevent poisoning in subsequent processing steps.” (Office Action, p. 8, lines 1-3, 7-9, 15-17.) Applicants respectfully request reconsideration on this point, for the following reasons.

In the cited figures in Tsai, as well as the balance of the reference, Tsai does not teach or suggest the use of a sacrificial layer at all. Whereas the invention of claims 1, 11, and 17 includes “depositing a non-conductive liner ... ; after depositing the non-conductive liner, depositing a sacrificial layer over the opening ... ; [and] removing the sacrificial layer sidewall ... forming a void, wherein the void extends along a side of the

contact via and the wire,” Tsai teaches “a low-k protection layer” formed over the substrate. This low-k protection layer is a solid structure comprising any of titanium nitride (TiN), titanium tungsten (TiW), titanium silicon nitride (TiSiN), tantalum nitride (TaN), tungsten nitride (WN), or materials like silicon dioxide (SiO₂), silicon nitride (SiN), silicon carbide (SiC), silicon nitrocarbide (SiNC), or silicon carbonitride (SiCN), and is intended to prevent detrimental effects including poisoning of hole openings due to outgassing from insulative layers, giving rise to voids, cavities for contaminants to enter, poor interfaces between contacting conductors, and poor connections between interconnects. (Tsai, [0038]-[0039].) Although FIG. 2E depicts the removal of the low-k protection layer 250 from the bottom of hole opening 245, exposing the under-lying passivation layer, low-k layer 250 remains on the vertical walls of the hole (Tsai, [0040]), and is never removed (Tsai, FIGS. 2F-I). Therefore, because Tsai does not teach the use of a sacrificial layer, it is not possible for Tsai to teach or suggest “depositing a non-conductive liner; [and] after depositing the non-conductive liner, depositing a sacrificial layer...”

Even if, *arguendo*, Tsai taught the feature of “depositing a non-conductive liner; [and] after depositing the non-conductive liner, depositing a sacrificial layer,” Applicants respectfully submit that a person having ordinary skill in the art as of the filing date of this application (September 30, 2004), would not have the requisite motivation to combine the teachings of Tsai with those of Nitta, Dubin, Roberts, and Cooney.

Tsai's low-k protection layer 250 is used for the stated purpose of “form[ing] a protective layer over the exposed surfaces of the low-k dielectric layer to prevent any of the detrimental effects” mentioned above. (Tsai, [0039].) The claimed invention,

however, includes “removing the sacrificial sidewalls ... forming a void, wherein the void extends along a side of the contact via and the wire; and depositing a cap layer over the void to form the gas dielectric structure.” The presence of the gas dielectric structure along a side of the contact via and wire renders a low-k dielectric layer (as in Tsai) unnecessary and irrelevant, as the problems Tsai seeks to cure are absent from the claimed method of forming a semiconductor structure. Specifically, the “detrimental effects” of poisoned hole openings due to outgassing from insulative layers, which give rise to voids, cavities for contaminants to enter, poor interfaces between contacting conductors, and poor connections between interconnects, do not exist in a semiconductor structure including the claimed gas dielectric structure because, as illustrated in FIG. 9, the void, or gas dielectric structure, “extends along a side of the contact via and the wire,” thus avoiding any possibility of poisoning the hole opening.

Accordingly, Applicants respectfully submit that the cited references fail to teach or suggest each and every element of claim 1. Because Cooney also fails to cure the deficiency in the cited references, Applicants also respectfully submit that the references cited by the Office also fail to teach each and every element of claims 11 and 17. Accordingly, withdrawal of the rejections of independent claims 1, 11, and 17 is respectfully requested.

With regard to dependent claims 4-5, 7-8, 13, 15-16, and 19-20, Applicants respectfully submit that these claims are allowable for reasons stated above relative to independent claims 1, 11, and 17, as well as for their own additional claimed subject matter. Accordingly, Applicants respectfully request that the Office withdraw the rejections under 35 U.S.C. § 103(a) to claims 4-5, 7-8, 13, 15-16, and 19-20.

IV. CONCLUSION

Applicants respectfully submit that the Application as presented is in condition for allowance. Should the Examiner believe that anything further is necessary in order to place the application in better condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

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